bundle of fibres each side of the middle line, and connected with the *commissura anterior*, with the *pars frontalis commissuræ anterioris* as described by Osborn for the kangaroo, by Flower and Sander for some other marsupials, by Ganser for the mole, and by Hamilton for the human brain. A second portion of the paper deals with the conformation of that portion of the Sylvian aqueduct which may be considered the homologue of the *torus longitudinalis* in the bony fishes.

Ueber den feineren Bau des Vorderhirns der Amphibien. A. OYARZUN. Archiv f. Mikros. Anatomie. B. XXXV, H. 3. Juni, 1890.

The author worked under the direction of Edinger and studied the forebrain in some amphibia (frog, triton and salamander). It has been the current view that undoubted ganglion cells could not be demonstrated in the mantel of the forebrain in vertebrates lower than the reptiles, and hence the homologue of the cerebral cortex of the mammals was considered to be first recognizable in this group. By using a modification of Golgi's method, Oyarzun has been able to demonstrate connective tissue cells and ganglion cells also in the mantel of these amphibia and show that the direction of the axis-cylinder processes from the ganglion cells is that which might be expected. The entire arrangement of the mantel is highly embryonic even in the adult frog, and this gives additional ground for considering the mantel in this case as but slightly differentiated.

II.—EXPERIMENTAL.

Les lois de la fatigue étudiées dans les muscles de l'homme. par ARNALDO MAGGIORA. Travaux de Lab. de Physiol. de Turin, 1889, p. 213. Also, Arch. f. Anat. u. Phys. (Phys. Abth.), H. 3-4, 1890, p. 191.

This is an experimental study, on the muscles of man, of the influences which favor and hinder muscular work. The experiments were made on the flexor muscles of the middle finger. The movements of the finger were recorded by the method described by Prof. A. Mosso in a paper having the same title as this and published in *Travaux de Lab. de Physiol. de Turin*, 1889,—p. 150, also *Archiv. Ital. de Biol.* XIII. p. 123, in a paper read before the Internat. Cong. of Physiol. at Basel, Sept. 1889, and in the *Archiv f. Anat. u. Physiol.* 1890, p. 89.

In the experiments of the author the muscles were stimulated voluntarily or by an induction current applied directly to them or their nerves. The contractions were always maximal, occurred at regular intervals and raised a weight of known amount, the weight being supported during the intervals. The contractions were continued until the power to raise the weight was lost. The record gave the height to which the weight was lifted by each contraction and thus the total amount of work done was readily computed. The amount of work possible was found to vary with the weight and the intervals of rest between the succeeding contractions.

With small weights the work can be continued a very long time even when the contractions succeed each other rapidly. With larger weights, one or more kilos, there is a certain weight for each individual with which, at a given rhythm, he can do the most work before the fatigue becomes complete. The curve of fatigue may be a straight line with a certain weight and a certain rhythm. If the rest between the succeeding contractions be ten seconds no fatigue is seen. The interval is sufficient for the restoration processes to be complete. This recalls the life long work of the heart. An interval of rest sufficient to prevent fatigue by a medium weight is insufficient with a larger weight. It is

not sufficient on doubling the weight to double the interval of rest. As the weight is increased the rest must be lengthened much more rapidly. This proportion would probably differ with each individual. In making a series of experiments in which the muscles were worked to fatigue, it was found that rests of 1½ to 2 hours must intervene between the successive experiments to enable the muscle to completely recover. The time required was found to vary greatly with the individual. The general condition and habit of life probably being very important factors. In experiments in which the maximal contraction was sought each time, it was found that the effort fatigued more than the work accomplished. Therefore to obtain the most work it was necessary to rest frequently. For example with two kilos, it was best to contract every two seconds for one minute and then rest one minute. To obtain the most work from a muscle during a day, the muscle should not be worked to complete fatigue, as work injures a fatigued muscle more than a greater amount of work hurts a fresh muscle. Though a muscle can recover from fatigue in two hours, it can do more work during a day if it makes only 15 contractions every half hour. Anæmia causes the muscle to fatigue rapidly even when a rate of contraction be chosen which does not normally cause fatigue. This was seen in experiments in which the anæmia was artificially produced by compression of the artery. Maggiora corroborates Mayer's statement that fatigue produced by long continued muscular work affects other muscles besides those which were engaged in the work and lessens their power. The fact that the first contractions of muscles thus weakened are good shows that their irritability is not lessened. Nevertheless these muscles rapidly weary, and this is true for electrical as well as voluntary stimuli, which shows that it is the peripheral as well as perhaps the central mechanisms engaged in the voluntary act, which are affected by the general fatigue. The effect is much the same as that seen in anæmia of the muscle. Further it was found that when the muscle was thus weakened by general fatigue it responded better to the will than to direct electrical stimuli. General muscular fatigue was caused in the case of the author, who was leading a sedentary life, by a walk of ten kilometres, while a march of 32 kilometres had little effect on two soldiers, and 64 kilometres were necessary to give a marked result in their case. After this long march the influence of the fatigue lasted one day, and on the next day they had recovered their muscular power. Loss of sleep was found to cause general fatigue of the muscles. A fast of twenty-four hours had the same effect. The power lost by fasting began to return almost immediately after food was taken and the muscle was capable of almost a normal amount of work half an hour after the meal. Experiments with electricity showed that the peripheral mechanisms were thus affected by the loss of sleep or lack of food and that the fatigue was general. Experiments with massage showed that a muscle recovers its power very rapidly if massaged during the interval of rest; fifteen minutes instead of two hours being sufficient to restore the muscle. Four times as much work can be done when the muscle is massaged during the period of rest as when it is simply allowed to remain quiet. When the intervals of rest are too short the muscle recovers less and less completely in spite of the massage. How far fatigue of the muscle is dependent on lack of nutriment and how far on the accumulation of the waste products resulting from the chemical changes occurring during work is uncertain. At the close the author states that the power of his muscles doubled in six months. This change was not due to exercise, but to an improvement in his general condition. W. P. L.